Exploring the Moon in the 21st Century: Themes, Goals, Objectives, Investigations, and Priorities, 2008

A Community Effort Coordinated by the
Lunar Exploration Analysis Group

Theme 1: Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them.

Theme 2: Use the Moon to prepare for future missions to Mars and other destinations.

Theme 3: Extend sustained human presence to the Moon to enable eventual settlement.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-1: Understand the geological evolution of the Moon (and other terrestrial bodies)

Investigation 1: Determine the internal structure and dynamics of the Moon to constrain the origin, composition, and structure of the Moon (*and other planetary bodies*).

Investigation 2: Determine the composition and evolution of the lunar crust and mantle to constrain the origin and evolution of the Moon (*and other planetary bodies*).

Investigation 3: Characterize the lunar geophysical state variables to constrain the origin, composition, and structure of the Moon (*and other planetary bodies*).

Investigation 4: Characterize the crustal geology of the Moon via the regolith to identify the range of geological materials present.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-2: Study of endogenous and exogenous volatiles on the Moon (*and other planetary bodies*).

Investigation 1: Characterize lunar volatiles and their source to determine their origin and to reveal the nature of impactors on the Moon.

Investigation 2: Determine the origin and distribution of endogenous lunar volatiles as one input to understanding the origin, composition, and structure of the Moon (*and other planetary bodies*).

Investigation 3: Characterize transport of lunar volatiles to understand the processes of polar volatile deposit origin and evolution.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-3: Improved knowledge of impact processes and impact history of the inner solar system.

Investigation 1: Characterize impact flux over the Moon's geologic history, to understand early solar system history.

Investigation 2: Characterize the impact process, especially for large basins, on the Moon and other planetary bodies to understand this complex process.

Investigation 3: Study meteorite impacts on the Moon to understand early Earth history & origin of life.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-4: Characterization of regolith and mechanisms of regolith formation and evolution.

Investigation 1: Study the lunar regolith to understand the nature and history of solar emissions, galactic cosmic rays, and the local interstellar medium.

Investigation 2: Characterize volatiles and other materials to understand their potential for lunar resource utilization.

Investigation 3: Determine lunar regolith properties to understand the *sub*surface geology and environment of the Moon and other airless bodies.

Investigation 4: Characterize the lunar regolith to understand the space weathering process in different crustal environments.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-5: Development and implementation of sample return technologies and protocols

Investigation 1: Provide curatorial facilities and technologies to ensure contamination and environmental control for lunar samples.

Investigation 2: Provide sample analysis instruments and protocols on the Moon to analyze lunar samples before returning them to Earth.

Theme 1, Goal 1A: Understand the formation, evolution and current state of the Moon.

Objective 1A-6: Understand the environmental impacts of lunar exploration.

Investigation 1: Determine baseline lunar environment parameters (exosphere, dust, radiation, etc., including composition and fluctuations therein).

Investigation 2: Establish a pre-human return monitoring network to quantify the environmental perturbations associated with exploration as well as due to natural phenomena (e.g., solar flares, meteoroid impacts, etc.).

Theme 1, Goal 1B: Use the Moon as a "witness plate" for solar system evolution.

Objective 1B-1: Understand the impact history of the Moon.

Investigation 1: Determine the early impact history of the Moon and inner solar system.

Investigation 2: Establish the impact flux over time.

Objective 1B-2: Understand the space weathering process to evaluate its effects on the Moon and other airless bodies.

Investigation 1: Characterize the lunar regolith to understand the space weathering process in different crustal enironments.

Theme 1, Goal 1C: Use the Moon as a platform for astrophysical, heliophysical, and earth-observing studies.

Objective 1c-1: Astrophysical Investigations using the Moon

- Low Frequency Radio Observations;
- Lunar High Energetic Observatory;
- Fundamental Physics (laser ranging);
- Lunar Optical Interferometer;
- Large Lunar Optical Telescope;
- Search of exotic stable states of matter.

Theme 1, Goal 1C: Use the Moon as a platform for astrophysical, heliophysical, and earth-observing studies.

Objective 1c-2: Heliophysical Investigations using the Moon

Near-Lunar Electromagnetic and Plasma Environment;

The Moon's Remnent Crustal Magnetic Fields;

Magnetotail Dynamics at Lunar Orbit;

Dust-Plasma Interaction on the Surface & Exosphere of the Moon;

Imaging the Heliopsheric Boundary;

Low-Frequency Solar Radio Astronomy;

Imaging Geospace from the Moon;

Analyze the composition of the Solar Wind;

High-Energy Optical Solar Observatory;

Sun's Role in Climate Change.

Theme 1, Goal 1C: Use the Moon as a platform for astrophysical, heliophysical, and earth-observing studies.

Objective 1c-3: Earth Science Investigations using the Moon

- Lightning;
- Variability of Earth's Top-of-Atmosphere;
- Earth Albedo Variability;
- Earth Land Surface Monitoring;
- Infrared Observations of Earth;
- Radar Interferometry of Earth.

Theme 1, Goal 1D: Use the unique lunar environment as a research tool.

OBJECTIVES AND INVESTIGATIONS STILL TO BE DEVELOPED